I. C. 6541

OCTOBER, 1931

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

MILLING METHODS AND COSTS OF THE CONIAURUM MINES, (LTD.), SCHUMACHER, ONTARIO

BY

JOHN REDINGTON

I.C.6541,
October, 1931.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

MILLING METHODS AND COSTS OF THE CONIAURUM MINES (LTD.), SCHUMACHER, ONTARIO[1]

By John Redington[2]

INTRODUCTION

This paper describing the milling practice at the Coniaurum Mine is one of a series of papers on milling methods, practice, and costs prepared in cooperation with an published by the United States Bureau of Mines.

The 500-ton mill of the Coniaurum Mines (Ltd.) is located at approximately the center of the company's property and a little more than a mile from the town of Schumacher, Ontario. The main shaft through which all the ore is hoisted is adjacent to the mill so that the ore hoisted in a 3-ton skip is dumped directly into a 15-ton bin at the crusher.

CHARACTER OF THE ORE

The ore as broken in the mine is comparatively fine, as the stopes are narrow, and consequently no large breaker is necessary. It consists of a mixture of quartz and mineralized schist carrying about $6 gold per ton and varies in size from 10-inch slabs down to fines. There is a very large proportion of fines which are very wet and at times give considerable trouble in the process of dry crushing. Little hope is held of improving the latter condition unless the veins should widen and thus allow a change in stoping so that the ore can be broken coarser.

CRUSHING PLANT

The flow sheet of the mill is shown in Figure 1.

The ore is drawn from the small bin into which the skip dumps by a "live-roll grizzly." This machine acts as a feeder to the gyratory crusher and at the same time removes the minus 1¼-inch material which would give trouble and reduce the capacity of the crusher. This grizzly was installed some months after the plant was started and considerable thought was given to the type of machine to be used. It was realized that a vibrating screen under proper conditions would remove a greater percentage of fines, but it was considered that with such a variety and size of feed (some slabs are 10 inches thick and 18 to 24 inches long) that the traveling grizzly would be more rugged and less costly to operate. In addition, a more uniform feed could be maintained, and our experience had shown that this was necessary for the best operation of the crusher.

The crusher is a 10-inch McCully type fine reduction gyratory and is directly connected to a 100-hp. motor. It is set for reduction to 1-3/4 inches and discharges onto a conveyor where the crushed product unites with the undersize from the grizzly. The ore is conveyed under a 36-inch lifting magnet to a centrifugal-discharge 18-inch bucket elevator. The latter raises the

---

[1] - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from the U. S. Bureau of Mines, Information Circular 6541."

[2] - One of the consulting engineers, U. S. Bureau of Mines, and manager, Coniaurum Mines (Ltd.).

Original from THE OHIO STATE UNIVERSITY

ore to a cylindrical steel bin of 700 tons capacity. A bin of such large capacity is used so that the crusher can be operated at one period and the rolls at another and thus save power, which is purchased on a peakload basis.

The ore is drawn from chutes in the bottom of this bin by conveyor belt and fed to the primary rolls. These are heavy duty 62 by 20 inch rolls fitted with 5-inch forged chrome-steel shells set to ½ inch. From the rolls the ore is conveyed to a centrifugal-discharge 18-inch bucket elevator which feeds two mechanically vibrated 4 by 5-foot screens. When the ore is very wet most of the trouble occurs at this point.

On these screens a punched plate is used with 7/16-inch round openings; the advantages of wire-cloth screen are realized, but the former type has been found to be best suited for the type of vibrator used and the character of the ore. The life of a screen is 6 weeks.

The oversize from the screen passes to a secondary roll in a closed-circuit arrangement, and the discharge of the secondary roll joins that from the primary roll. The undersize from the screen drops on to a conveyor and goes to the main 1,000-ton bin, in the cyanide plant.

Following is the screen analysis of the product as it leaves the crushing plant:

Mesh	Per cent	Mesh	Per cent
Plus 4	11.14	Plus 35	5.85
Plus 6	14.02	Plus 48	2.82
Plus 8	12.23	Plus 60	2.40
Plus 14	19.53	Plus 100	3.02
Plus 20	8.90	Plus 150	1.45
Plus 28	6.13	Plus 200	0.94
		Minus 200	11.57

The secondary rolls are the same as the primary but are run at a higher speed and are set as close as it is possible to keep them. This setting of the rolls is governed by the power taken to drive them, as shown by the ammeter. The operator controls the feed also by the ammeter and forces it at maximum rate at all times. In this way the shells are worn uniformly by the crushing action of the ore itself and require very little dressing. No cutting of shells has been necessary and those on the primary rolls show very little grooving while on the secondary rolls they have a smooth surface at all times. The little dressing of the shells that is necessary is done with carborundum bricks on the edges while running. The shells wear down until they are 3/4 to 1 inch thick when they loosen or start to spread and are then discarded.

Each roll is driven separately by a 16-inch belt from a 35-hp. motor. The motors on the primary roll are fully loaded and on the secondary rolls are about 30 per cent overloaded. The capacity of the rolls varies a great deal, and when working on a very wet ore, as mentioned previously, it is reduced considerably. The average capacity on all ore is very close to 45 tons per hour. The coarse crushing rolls operate at a peripheral speed of 1,090 feet per minute, with new shells, and the fine rolls at 1,330 feet per minute.

All conveyors use a 24-inch belt and are equipped with Timken tapered roller-bearing idlers.

CYANIDE PLANT

The bin in the cyanide plant is of the cylindrical steel flat-bottom type. The ore is drawn by conveyor from chutes in the bottom and is fed by launder with cyanide solution to a 30 by 6 foot Dorr duplex classifier in closed circuit with a 5 by 16 foot tube mill. Two grinding units are available, but at present only one is in use. The classifier is placed

Digitized by Google Original from THE OHIO STATE UNIVERSITY

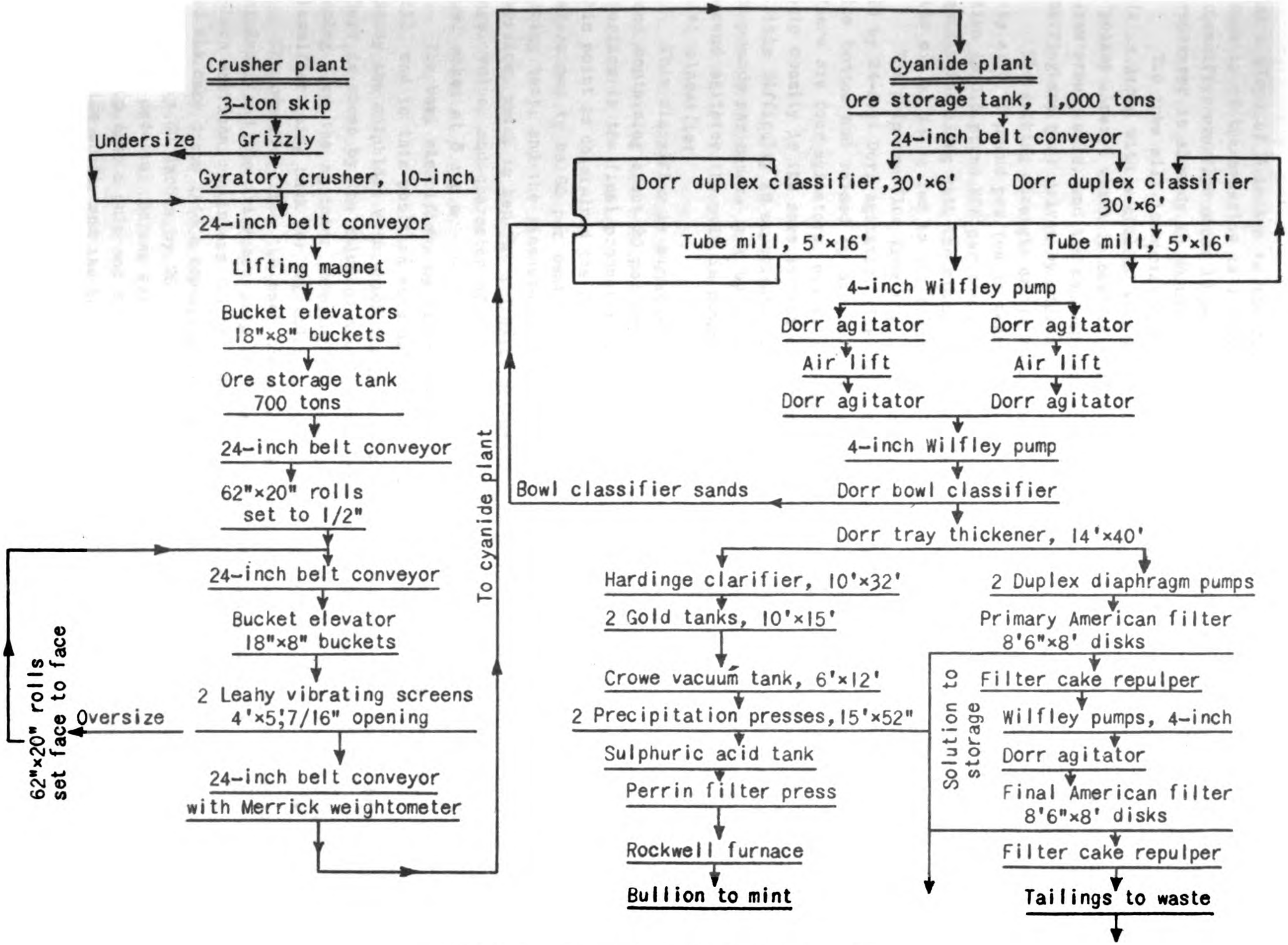

Figure 1.– Flow sheet of Coniaurum mill

at a slope of 3 inches to the foot, and the rakes are run at 24 strokes per minute. The density of the overflow is 1.2 parts of solution to 1 of solids. A screen analysis of the classifier overflow shows 10 per cent plus 65-mesh, and at this point 75 per cent of the gold recovered is already in solution.

The tube mill is operated at 28 r.p.m., with a moisture content of 28 to 30 per cent. It is lined with a chilled white-iron liner 2½ inches thick of a patented type called the "pocket liner," which is cast in this vicinity. The grinding media are 2-inch balls forged from steel rails, and the consumption is 1.8 pounds per ton of ore. The drive consists of a herringbone gear driven by pinion directly connected to a 150-hp. motor.

The working strength of the solution is kept at 1.25 pounds of KCN per ton, and alkalinity at 0.75 pound per ton in terms of CaO. The cyanide used is Aero brand and the consumption is 0.5 pound KCN per ton of ore. The cyanide is added at regular intervals in weighed quantities along with the classifier sands entering the tube mill. The lime is added dry to the ore as it is fed to the crusher.

The pulp overflow from the classifier is pumped by a 4-inch centrifugal sand pump to a 20 by 24-foot Dorr agitator. The speed of the rakes is 8 r.p.m., and the pulp is drawn from the bottom and raised by air lift to the second agitator, giving a contact of 16 hours. There are four agitators, but at present only two are being used with the one tube mill. The pulp density is the same as that overflowing the classifier, and, although it is very coarse little difficulty is experienced in keeping it in suspension. Compressed air is supplied at 25 pounds per square inch by a single-stage compressor driven by a 60-hp. motor. From the second agitator the pulp is pumped by a 4-inch centrifugal sand pump to a 17-foot diameter bowl classifier.

This classifier is supported by steel columns on a floor above the tube mills, and the sand containing about 20 per cent of moisture is run by chute back to the tube mill. The overflow is the final product from the grinding, agitating, and classifying circuit and at this point is determined the fineness of grinding. The economical point of grinding has been determined to be 60 per cent minus 200-mesh; a daily sample of the overflow is taken for sizing test, and the fineness is controlled by regulating the specific gravity of the pulp overflow, which is kept at a density between 2.1 to 1 and 2.5 to 1, depending upon the tonnage, value, and character of the ore. The reciprocating rakes run at 16 r.p.m. and the bowl rakes at 5 r.p.m.

The bowl classifier, as can be seen is in closed circuit with the agitators and tube mill, and in this position acts as a concentrator and gives an opportunity to grind selectively the sulphides with which the gold is closely associated. Its importance in the flow sheet is shown by the value of the samples taken of the different products. With the pulp coming from the agitator assaying 60 cents per ton the value of the sands from the bowl classifier going back for regrinding ranges from $3.75 to $4. a ton.

The overflow from the bowl classifier runs by launder to a 40 by 14-foot Dorr tray thickener and the thickener pulp is drawn by Diaphragm pump and fed to an 8-disk 8-foot 6-inch American continuous filter. Here it is filtered and given a barren solution wash, and the cake drops into a repulping machine. This consists of a shallow wooden tank 12 feet 6 inches by 30 inches by 28 inches fitted with a horizontal shaft on which are fastened heavy iron paddles. Barren solution flows into the tank, and as the paddles revolve the cake is broken up into a pulp and flows from the tank. The height of the pulp is kept below the bottom of the shaft, and the bearings are set outside the machine so that no trouble is experienced from slime getting into them.

The pulp, which as stated above is mixed with barren solution, is next pumped to an 18 by 20 foot Dorr agitator and drawn from this agitator to a second filter similar to the first one. On this filter it is given a water wash, and the cake drops into another repulper, is mixed with water, and runs by gravity to the tailings pond.

A two-stage Rees Roturbo pump is used with each filter unit; in fact, all solution pumps are of this make and are either single-stage or two-stage. The filtrate can be pumped to the circulating solution tank or taken into the circuit at other different points when necessary. Vacuum for the filter is furnished by a 23 by 12 inch duplex pump driven by a 75-hp. motor.

On the primary filter a row of sectors is taken off every second day and placed in a small wooden tank with a dilute solution of muriatic acid to remove the lime. On the secondary filter where water wash is used and lime formation is more rapid, a row of filter bags is treated every day. This gives a period of 20 days per filter bag on one filter and 10 days on the other. The bags are repaired by hand by the operators and the average life of each, including the repaired ones, is 130 days.

The overflow from the Dorr thickener runs to a Hardinge sand clarifier. The sand through which the solution filters is all minus 1/4-inch, with the following screen analysis:

Mesh	Per cent
Plus 20	29.05
Plus 100	67.45
Minus 100	3.50

In operation, the solution is allowed to filter through the sand bed until the rate of filtration is slower than the rate of precipitation. The scrapers are then revolved, scraping the slime to the center and drawing it from the bottom of the tank. If this does not increase the filtering capacity quickly enough, the scrapers are lowered from 1/16 to 1/8 inch, and that much sand is cut off the top of the filter bed. We have found this a very satisfactory method of clarification - one requiring little attention and low in cost. A new charge of sand which is still in use was put into the tank in March, 1929, and should last until the summer of 1931.

From the clarifier the solution is pumped by centrifugal pump to the 10 by 15 foot gold tanks, and then from the Crowe vacuum system to the precipitation press. This is similar in all respects to the customary practice except that a centrifugal pump is used in place of a reciprocating pump to deliver the pregnant solution to the press. The problem of eliminating the air from this type of pump is overcome by connecting the glands of the pump by a small pipe line to the Crowe vacuum tank through which any air that enters the pump is drawn away by vacuum.

Six hundred and fifty tons of solution is precipitated every 24 hours. The consumption of zinc dust is 0.025 pound per ton of solution, and a precipitate is obtained averaging $175 per pound. Lead nitrate is added to the clarified solution at the rate of 1½ pounds per 24 hours.

The clean-up of the precipitate takes place once each month. It is scraped roughly from the cotton sheeting which overlies the 10-ounce duck on the press, and the sheeting is burned.

The small amount of ashes with flux goes directly to the furnace. The precipitate is given a sulphuric-acid treatment, forced into a press with air, washed, and dried with air to about 35 per cent of moisture. It is then fluxed with soda ash, borax, fluorspar, and silica and refined in a Rockwell furnace. A proportion of the slag is rerun or used with the flux, and the excess slag which amounts to very little is returned to the tube mill. The resulting bullion averages 850 fine in gold and 110 fine in silver.

The recovery for the full year 1930 was 96.35 per cent; and the costs, without depreciation, for the same period are given below:

Total tons milled	122,972
	Cost per ton
Crushing, screening, and conveying to cyanide-plant bin	$0.346
Tube milling and classification	.202
Agitating and thickening	.072
Clarification and precipitation	.042
Reagents	.087
Double filtration	.113
Tailings disposal	.015
Refining	.016
Pumping	.046
Total	0.939

CONSUMPTION OF MATERIALS AND REAGENTS

Ball consumption	1.8 pounds per ton of ore milled
K.C.N. consumption	0.5 pounds per ton of ore milled
Zinc dust consumption	0.025 pounds per ton of solution (650 tons solution per 24 hours)
Lead nitrate	1.5 pounds every 24 hours
Life of vibrating screens	6 weeks
Life of filter bags	130 days